Site Survey of the Mine Burial/Coastal Processes Experiment Site at the WHOI Coastal Observatory, Martha's Vineyard

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LONG-TERM GOALS

The primary goal of the ONR Mine Burial Prediction Program is to provide to the Navy quantitative estimates of the likelihood of mine burial following deployment. To do this, it is essential to have an accurate assessment of the geologic and oceanographic conditions and understanding of the sedimentary processes acting in proximity to the mines.

OBJECTIVES

The ONR Mine Burial working group, which met in St. Petersburg at the end of January 2001, identified Woods Hole Oceanographic Institution's coastal observatory off the coast of Martha's Vineyard (Figure 1) as one of two primary test sites. Our primary objective was to conduct a thorough site survey of this region – including swath mapping, geotechnical measurements, sampling, coring and seismic reflection. Our expectation is not only to establish the basic geological conditions at the mine burial test site, but also to put the test site in a more regional geologic context of a basic understanding of the processes acting in this near shore environment. The site survey is intended as a baseline against which changes in the seabed can be measured.

APPROACH

The site survey of the Martha's Vineyard Coastal Observatory (MVCO) was a collaborative effort among a number of PI's within the ONR Mine Burial Prediction Program. John Goff (UTIG) acted as site survey coordinator, and chief scientist for the work aboard the *R/V Cape Henlopen*. Goff was also to conduct grain size analysis of grab samples collected. Larry Mayer (UNH), a co-PI on this proposal, planned and oversaw high resolution swath mapping using the Reson 8125 focused multibeam system. The UNH group also collected velocity and resistivity measurements with the ISSAP (*In-situ* Sound Speed and Attenuation Probe) instrument. Grab samples and geotechnical measurements were collocated so that grain size distribution could be compared with velocity and porosity. Bill Schwab (USGS-Woods Hole) conducted a backscatter and bathymetry survey in September 2001 using a Submetrix system. Roy Wilkins (U. Hawaii) coordinated use of the vibracore system, and oversaw grain size analysis from the cores. Rob Evans (WHOI) and Steve Schock (FAU) conducted a chirp seismic reflection survey. John Goff performed stratigraphic analysis of the chirp data. Peter Traykovski (WHOI) has also been collecting sediment samples and pole-mounted sector scanning sidescan data to image bedforms.

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14. ABSTRACT
The primary goal of the ONR Mine Burial Prediction Program is to provide to the Navy quantitative estimates of the likelihood of mine burial following deployment. To do this, it is essential to have an accurate assessment of the geologic and oceanographic conditions and understanding of the sedimentary processes acting in proximity to the mines.

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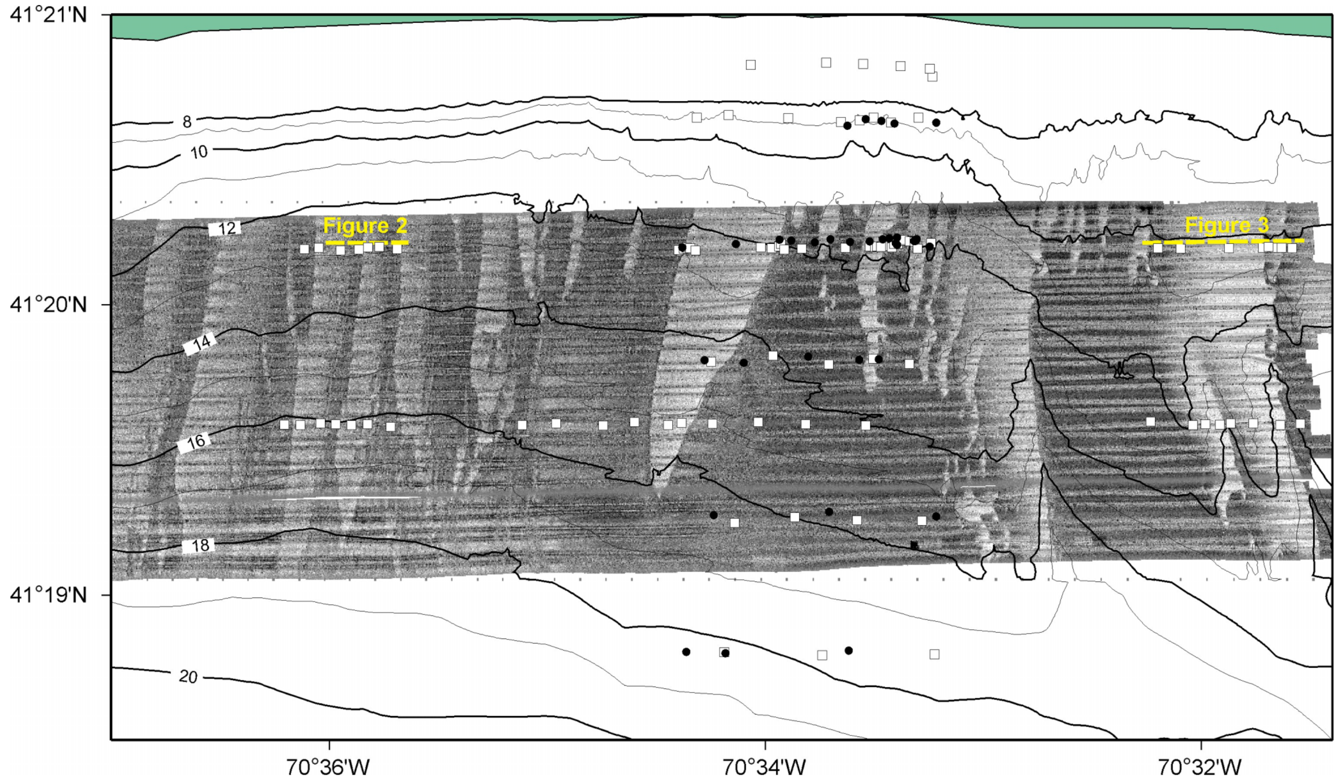

Figure 1. Locations of grab samples (white squares), cores (black circles) collected during CH02-15. Velocity/resistivity measurements were collocated with all grab samples. Background image is submetrix sidescan data (USGS, September 2001) with regional bathymetric contours in meters. Higher backscatter intensity is shown by lighter shades. Location of seismic lines and profiles shown in Figures 2 and 3 are indicated

WORK COMPLETED

The USGS Submetrix survey was completed in September, 2001. The Reson 8125 multibeam survey was completed in July, 2002. The *R/V Cape Henlopen* cruise, including three legs dedicated to vibracoring, grab sampling and ISSAP probe, and chirp profiling, was concluded in August, 2002. Grain size analysis has been completed on both the grab samples and cores. The chirp seismic data has been interpreted and correlated to surface morphology and results from the grab sample and core analyses.

RESULTS

Our initial results from the seafloor mapping and sampling, detailed in the previous progress report, established the strong distinction between areas of coarse sand (so-called "rippled scour depressions," or RSD; e.g., Cacchione et al., 1984; Theiler et al., 1995; Schwab et al, 1997) and intervening fine sands, which are clearly in evidence in the contrasting backscatter intensities (Figure 1). Coring reveals that the fine sands overly the coarse; presumably the fines are winnowed from the coarse, and collect only where fine sands have been established. The more heavily rippled coarse sands prevent accumulation of fines through higher bottom shear stresses. Beyond this understanding, however, the formation, maintenance and evolution of RSD's are poorly understood. The map view reveals that the RSDs are highly asymmetric: backscatter is higher, the coarse/fine transition is more sharply defined,

and the scour depression is deeper on one side than the other. This pattern changes within the survey: the higher backscatter edge is always to the west in the western part of the survey, and vice versa to the east. Proximity of RSDs of such striking contrasts is a unique observation, and one we feel will, in conjunction with a better understanding of the oceanography of this area, provide strong constraints on models for RSD formation.

The recently-completed seismic interpretations, combined with collocated bathymetric and backscatter profiles, provide a cross-sectional view of the west (Figure 2) versus east (Figure 3) RSD structures. In both locations, the coarse/fine seismic horizon (ground truthed elsewhere by coring) appears to intersect the seafloor at the more sharply defined RSD boundary (the east side of the eastern RSDs, and west side of the western RSDs). On the other side of the RSD, however, there is no clear termination of this horizon, and in many cases can be seen to continue as a distinct seismic horizon beneath the coarse sands. To the east, where the shallow horizon appears to outcrop at the seafloor within the coarse unit, grab samples indicate a significant fraction of gravel (Figure 3). It is suggested that the shallow horizon beneath the coarse sand seafloor may be a contact between well-sorted, mobile coarse sands above and poorly-sorted host sediments below. Another east vs. west contrast is seen in the relationship between the RSD edges and the bathymetry. In the east (Figure 3), both sides of the RSD are marked by local bathymetric lows, with the sharp edge much deeper than the other edge. To the west (Figure 2), the most prominent bathymetric lows are offset just to the east of the sharp RSD boundary.

IMPACT/APPLICATIONS

Our site survey and time series observations should lead to a substantial advancement in the understanding of the dynamics of the MVCO in particular, and RSDs in general.

RELATED PROJECTS

None that I am aware of.

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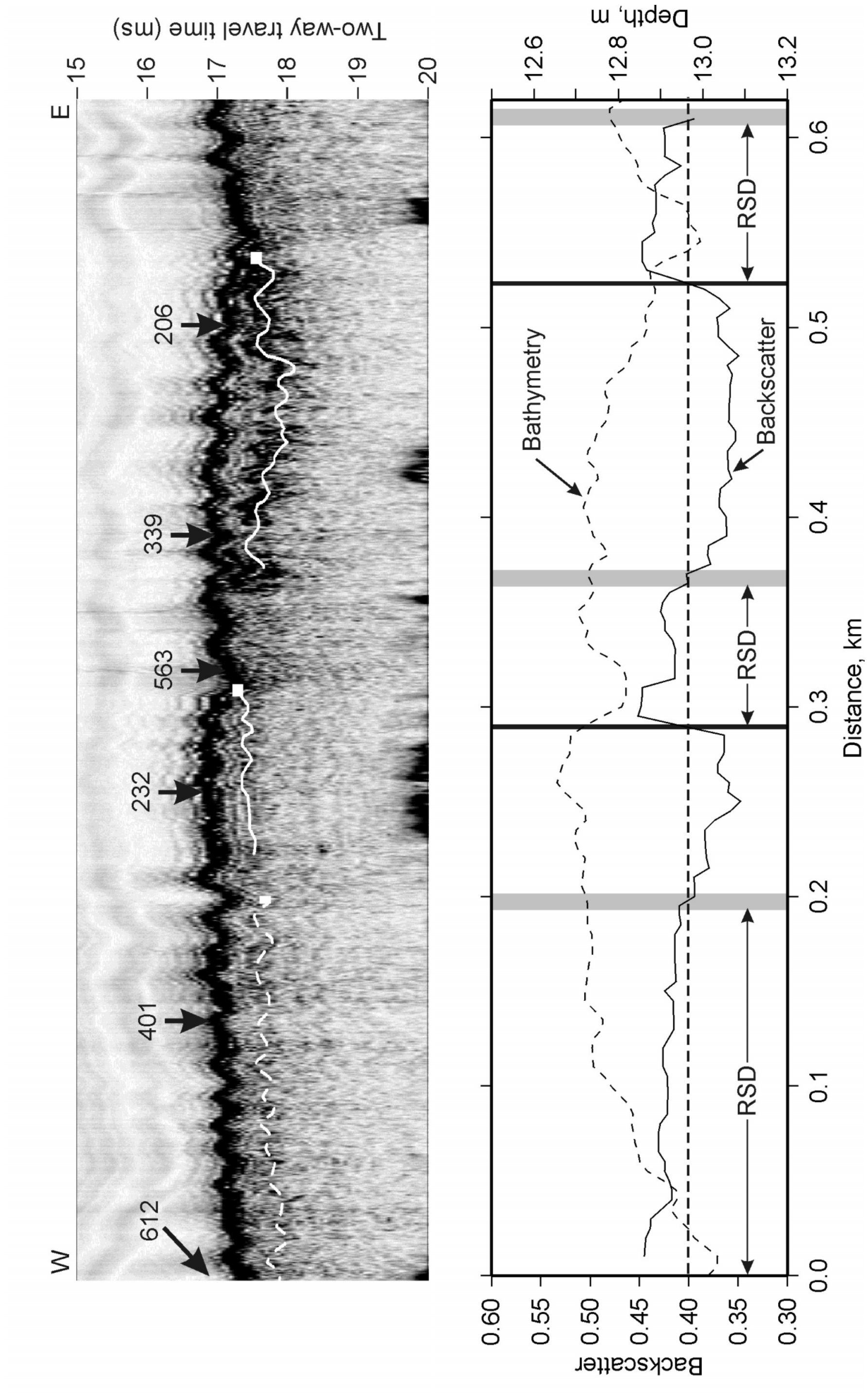

Figure 2. Top: interpreted chirp seismic cross section across RSDs in the western survey area (Figure 1). Solid white line identifies the shallow seismic horizon beneath the fine sands, evidently the contact between fine sands above and coarse sands below. Dashed lines represent a sporadic horizon beneath the coarse sands, which may be a contact between well-sorted coarse sands above and poorly sorted coarse sands below. Values indicate seafloor mean grain sizes in microns. Bottom: Backscatter and bathymetry profiles across the seismic profile, averaged along structural trends to reduce noise. Vertical bars indicate RSD transitions: sharp, western boundaries by black, and gradual boundaries by gray.

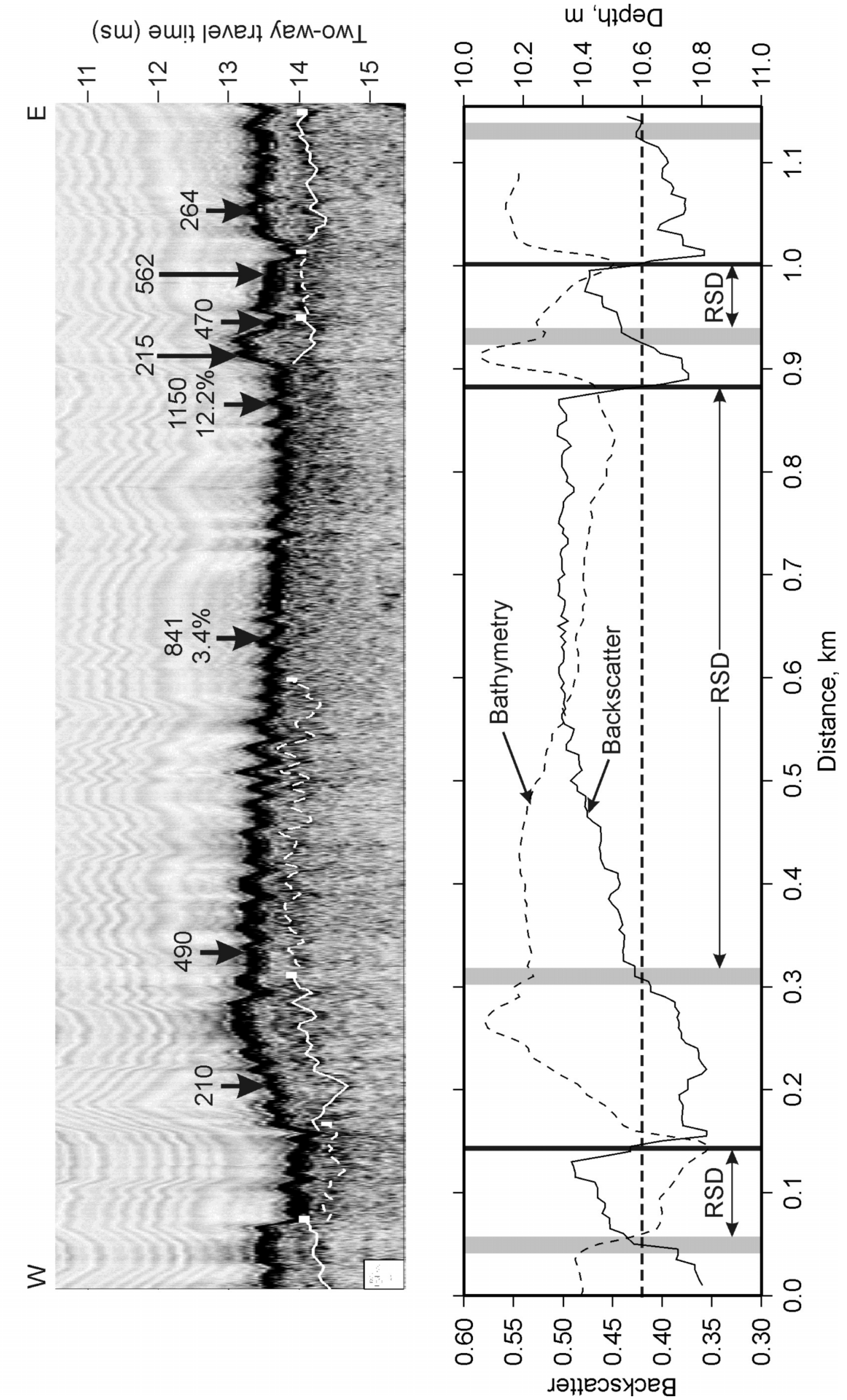

Figure 3. Same as Figure 2 for seismic, backscatter and bathymetry profile across RSDs in the eastern survey area (Figure 1). Percentage values at top indicates gravel fractions greater than 2%.